BJA

British Journal of Anaesthesia, 125 (1): e81–e87 (2020)

doi: 10.1016/j.bja.2020.03.010
Advance Access Publication Date: 14 April 2020
Clinical Investigation

Incidence and risk factors for maternal hypoxaemia during induction of general anaesthesia for non-elective Caesarean section: a prospective multicentre study

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Abstract

Background: Pregnant women are at increased risk of hypoxaemia during general anaesthesia. Our aim was to determine the incidence and the risk factors that contribute to hypoxaemia in this setting.
Methods: Every woman 18 yr or older who underwent a non-elective Caesarean section under general anaesthesia was eligible to participate in this multicentre observational study. The primary endpoint was the incidence of hypoxaemia defined as the SpO_2 ≤95%. The secondary endpoint was the incidence of difficult intubation defined as more than two attempts or failed intubation.
Results: During the study period, 895 women were prospectively included in 17 maternity hospitals, accounting for 79% of women who had general anaesthesia for non-elective Caesarean section. Maternal hypoxaemia was observed in 172 women (19%; confidence interval [CI], 17–22%). Risk factors associated with hypoxaemia in the multivariate analysis were difficult or failed intubation (adjusted odds ratio [aOR]=19.1 [8.6–42.7], $P<0.0001$) and BMI >35 kg m^{-2} (aOR=0.53 [0.28–0.998], $P=0.0495$). Intubation was difficult in 40 women (4.5%; CI, 3.3–6%) and failed intubation occurred in five women (0.56%; CI, 0.1–1%). In the multivariate analysis, use of a hypnotic drug other than propofol was associated with difficult or failed intubation (aOR=25 [2–391], $P=0.02$). A propensity score confirmed that propofol was associated with a significant decreased risk of difficulty or failure to intubate ($P<0.001$).
Conclusions: Hypoxaemia during Caesarean sections was observed in 19% of women and was significantly associated with difficult or failed intubation. The use of propofol may protect against the occurrence of difficult intubation.

Keywords: airway management; Caesarean section; difficult intubation; general anaesthesia; hypoxaemia; pregnancy; propofol; tracheal intubation

Received: 11 December 2019 **Accepted:** 10 March 2020

Editor's key points

- Pregnant women undergoing non-elective Caesarean section are at increased risk of hypoxaemia during general anaesthesia.
- Hypoxaemia (SpO_2 ≤95%) occurred in 19% of women, and difficult or failed intubation and BMI >35 kg m^{-2} were risk factors.
- The use of propofol was associated with a decreased risk of difficult or failed intubation, and may protect against the occurrence of difficult intubation.

In Western Europe, up to 25% of pregnant women are delivered by Caesarean section.[1] Neuraxial anaesthesia is preferred to general anaesthesia (GA). The current rate of GA is only 5% on average, and it is mainly chosen for the management of emergent Caesarean deliveries.[2,3] Compared with neuraxial anaesthesia, GA increases the risks of difficult airway management and respiratory complications. The most important life-threatening event during difficult airway management is hypoxaemia, which could lead to death in the most severe cases.[4–6] To date, only one previous prospective and observational study investigated airway management during GA for Caesarean section. Severe hypoxaemia (SpO_2 <85%) occurred in 24 of 1095 (2%) parturients.[7] Yet, despite many reports and guidelines, no study has ever been performed to identify risk factors for hypoxaemia in this context. Identifying such risk factors may help physicians prevent and decrease the occurrence of hypoxaemia.

The aim of the current prospective study was to determine the incidence of hypoxaemia and its determinants during induction of GA for non-elective Caesarean delivery.

Methods

Between June 2015 and November 2016, 17 public maternity units from the French region Ile-de-France participated in this prospective observational survey. The Ethics Committee of the French Society of Anaesthesia and Intensive Care (SFAR, IRB 00010254-2015-013, Pr E. Bazin) approved this study (2015). The Ethics committee waived the requirement for written informed consent. The French laws on biomedical research (Article L.1121-1-1 and Article R.1121-3 of the public health code) do not apply to this non-interventional study. Thus, we did not register our study on a publicly accessible site.

Participants

Women 18 yr or older who had non-elective Caesarean section under GA in one of the participating maternity units were eligible to participate in this study.

Data collection

One or two investigators per maternity unit were responsible for prospective data collection using a standardised anonymised record form. Maternal and pregnancy characteristics were collected: maternal age, American Society of Anesthesiologists (ASA) physical status, gestation age at delivery (in weeks of gestation), pre-existing medical conditions; BMI at the beginning of the pregnancy (in kg m^{-2}), recognised risk factors for difficult intubation (Mallampati score >2, limited jaw protrusion, limited thyromental distance [<65 mm], limited mouth opening [<30 mm]). Characteristics of the maternity unit were also recorded: level of neonatal care (Level I hospital, birth centre without on-site neonatology unit; level II, birth centre with on-site neonatology unit; level III, birth centre with on-site neonatal ICU), total number of deliveries per year, annual rates of Caesarean deliveries. Indications for Caesarean section were collected, and the degree of emergency was described in four categories according to the classification of Lucas and colleagues[8]: category 1, immediate threat to life of mother or fetus; 2, maternal or fetal distress which is not immediately life threatening; 3, no maternal or fetal compromise but need for an early delivery; and 4, delivery timed to suit both woman and staff.[8] Indications of GA were recorded as follows: request for immediate fetal extraction, failed neuraxial anaesthesia (any neuraxial anaesthesia during which the patient requests supplemental analgesia leading to GA), contraindications of neuraxial anaesthesia, obstetrician request for GA, and others.

The procedures of induction of GA and airway management were described: procedures of preoxygenation with a pre-set gas flow of at least 12 L min^{-1} O_2 (machine circuit): the patients were asked to breath normally (tidal volume breathing) or deeply (vital capacity breaths) with the aim of reaching at least 90% FeO_2, the use of rapid-sequence induction, the nature of the hypnotic drug administered; and for the first attempt of laryngoscopy, the operator: trained (nurse or senior anaesthetist) or novice (resident anaesthetist), laryngoscopic view according to the Cormack and Lehane classification (grades 1–4), and the technic of tracheal intubation (direct laryngoscopy with or without stylet).

Maternal pulse oximetry of arterial oxyhaemoglobin saturation (SpO_2) and expired oxygen fraction (FeO_2) were collected at the end of preoxygenation and before the induction of anaesthesia. Difficult preoxygenation was defined as a FeO_2 level of less than 90%. FeO_2 was measured at each breath, using a calibrated gas analyser located in the ventilator, with a sample line connected to the filter placed between the Y-piece and the mask. Minimal SpO_2 values during airway management were recorded. Hypoxaemia and severe hypoxaemia were defined as SpO_2 of ≤95% and ≤90%, respectively, at any time of the procedure.

A difficult intubation was defined as more than two attempts (i.e., three or more). Failed tracheal intubation was defined as the failure to achieve successful tracheal intubation irrespective of the technic(s) used according to the most recent guidelines.[9,10] The technic for successful management of difficult airway was described as multiple attempts of direct laryngoscopy, use of a gum elastic bougie (GEB), use of a laryngeal mask airway (LMA), use of a videolaryngoscope (Airtraq® laryngoscope, AQ-L; VYGON, Ecouen, France) or McGrath® Laryngoscope (VIDL; McGrath® MAC EMS; Aircraft Medical, Edinburgh, UK). Critical respiratory incidents such as regurgitation, aspiration, bronchospasm, and laryngospasm were recorded. The anaesthesiologist in charge of the patient collected all these data. For each patient, the study period finished at the end of airway management, and then the anaesthetic procedure was performed.

Endpoints

The primary endpoint was the incidence of hypoxaemia defined as the SpO_2 ≤95%. Risk factors for hypoxaemia were investigated during the preoperative visit (characteristics and medical history of the patient) and during induction of anaesthesia (difficult preoxygenation, operators, hypnotic drug used, and difficult or failed tracheal intubation).

Table 1 Characteristics of the participating maternity units ($n = 17$). Level III hospital, birth centre with on-site NICU; level II hospital, birth centre with on-site Neonatology unit. CS, Caesarean section; GA, general anaesthesia; NICU, neonatal ICU.

Maternity units	Level	Deliveries (*n*)	CS rate (%)	Non elective CS under GA (% of CS)
Total		**68 392**	**21.6**	**7.6**
AP-HP-Cochin-Port Royal, Paris	III	6785	25.4	7.2
Delafontaine, Saint Denis	III	6067	23.1	7.5
André Grégoire, Montreuil	III	5796	18	9.1
AP-HP-Trousseau, Paris	III	5459	23.3	3.6
AP-HP-Antoine Béclère, Clamart	III	5083	23.3	8.9
AP-HP-Le Kremlin-Bicêtre	III	4898	19.7	5.3
Créteil, Créteil	III	4578	23.8	10.1
René Dubos, Pontoise	III	4079	18.7	7.5
AP-HP-Robert Debré, Paris	III	4031	15.3	12.3
AP-HP-Louis Mourier, Colombes	III	2479	22.8	8.5
Foch, Suresnes	II	3797	20.6	6.0
AP-HP-Lariboisière, Paris	II	3591	19.2	8.1
Villeneuve St Georges	II	3320	22.2	6.0
AP-HP-Pitié Salpêtrière, Paris	II	2269	26.4	7.5
AP-HP-Jean Verdier, Bondy	II	2254	21.7	10
AP-HP-Bichat, Paris	II	2208	23.1	8.4
AP-HP-Tenon, Paris	II	1698	22.9	10.1

The secondary endpoint was the incidence of difficult or failed intubation. Risk factors for difficult or failed intubation were also investigated during the preoperative visit (characteristics and medical history of the patient, recognised risk factors for difficult tracheal intubation), and during induction of anaesthesia (hypnotic drug used, operators).

Statistical analysis

Considering that overall incidences of hypoxaemia ($SpO_2 \leq 95\%$) and difficulty or failure to intubate were expected about 15% and 5%, respectively, we included a total of 890 patients to allow a power larger than 80% to identify by multivariate logistic regression a risk factor associated to an odds ratio (OR) equal to 2 for the outcome 'hypoxaemia' and to 3 for the outcome 'difficulty or failure to intubate'. We used the methods proposed by Hsieh[11] considering a 20% rate of patients with the risk factor, a squared multiple correlation coefficient R^2 for the variables equal to 0.25, and a two-sided 5% alpha value. Quantitative data are summarised as mean (standard deviation, SD) or median and IC25–75. Categorical variables are presented as percentages and 95% confidence intervals or extremes. Factors associated with difficult intubation and with hypoxaemia were explored among individual characteristics and characteristic of GA using uni- and multivariate analysis. Data were compared using a χ^2 test for categorical variables and a Student's *t*-test or Wilcoxon rank sum test for continuous variables.

Covariates were identified according to the literature and to the results of the univariate analysis. All factors with $P<0.10$ in the univariate analysis were included in a multiple logistic regression model. To test specifically the impact of the drug used for anaesthesia (thiopental *vs* propofol), we used analysis based on propensity score (PS). For this purpose, we tested three different PS methods: inverse probability of treatment weighting (IPTW), standardised mortality ratio (SMR)-weighted methods, and adjustment on PS. For the final analysis, we used IPTW that optimise the balance of covariables. All tests were two-sided, at a 0.05 significance level. All analyses were performed using SAS Version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

During the study period, 895 women who underwent induction of GA for emergent Caesarean sections were prospectively included in 17 maternity hospitals, accounting for 79% (range, 60–95%) of all women who had a GA for a Caesarean delivery during the study period (Table 1). The mean maternal age was 31 (6) yr and the mean BMI was 29 (5) kg m^{-2}. The mean gestational age was 36 (4) weeks. Most of the included parturients were ASA physical status 1 or 2 ($n = 840$; 94%), 52 women (6%) were ASA 3, and three women (0.4%) were ASA 4. Caesarean sections were classified as Category 1 for 439 women (49%), Category 2 for 287 women (32%), and Category 3 for 169 women (19%). Indications of Caesarean sections and of GA are displayed in Tables 2 and 3, respectively. The most frequent indications for non-elective Caesarean sections were fetal heart rate abnormalities (Table 2). The two most frequent

Table 2 Indications for non-elective Caesarean section ($n = 895$ women). *Severe preeclampsia or HELLP syndrome or eclampsia. HELLP, haemolysis elevated liver low platelets.

	n (%)
Abnormal fetal heart rate	350 (39)
Prolonged labour/dystocia	125 (14)
Placenta abruption	98 (11)
Severe pregnancy hypertensive disorders*	86 (9.6)
Umbilical cord prolapses	57 (6.4)
Abnormal placentation	38 (4.2)
Maternal sepsis	30 (3.3)
Uterine rupture	24 (2.7)
Antepartum obstetric haemorrhage	10 (1.2)
Others	77 (8.6)

Table 3 Indications of general anaesthesia (n = 895 women). *Any neuraxial anaesthesia during which the patient requests supplemental analgesia leading to general anaesthesia.

	n (%)
Request for immediate fetal extraction	305 (34)
Failed neuraxial anaesthesia*	280 (31)
Failed epidural anaesthesia	190 (21)
Failed spinal anaesthesia	60 (6.6)
Unspecified	30 (3.4)
Contraindications of neuraxial anaesthesia	177 (20)
Coagulopathy/bleeding	104 (12)
Maternal refusal	30 (3.4)
Maternal sepsis	32 (3.5)
Haemodynamic instability	11 (1.3)
Obstetrician request	104 (11.6)
Others	29 (3.3)

indications for GA were requests for immediate fetal extraction and failure of neuraxial anaesthesia (Table 3).

Rapid-sequence induction was used in all the cases. Thiopental (n=650; 73%) was the hypnotic drug most often used, with wide variability between maternity hospitals (from 16% to 95%). Propofol was used in 235 women (26%), whereas etomidate or ketamine was the preferred hypnotic agent for nine and one cases, respectively. Suxamethonium was given in all cases but six who received rocuronium.

Airway management

Tidal volume breathing and vital capacity breaths were the most frequent procedures for preoxygenation, at 75% and 21%, respectively (Table 4). Nurse anaesthetists or residents mostly performed the first attempt of direct laryngoscopy. Intubation was difficult in 40 women (4.5%; CI, 3.3–6%) and successfully managed mainly using GEB. Failed intubation occurred in five women (0.56%; CI, 0.1–1%). LMA was successfully inserted in all five cases, and Caesarean section was then allowed to proceed. No case of aspiration was reported.

Table 4 Airway management in general anaesthesia for non-elective CS (n = 895 women). Data are presented as n (%). *136 missing data. †Difficult intubation was defined as more than two attempts at intubation. ‡Failed intubation was defined as unable to intubate.

	n (%)
Direct laryngoscopy: first attempt	
Operators	
Nurse anaesthetist	415 (46.4)
Senior anaesthetist	141 (15.7)
Resident anaesthetist	339 (37.9)
Cormack and Lehane classification	759*
1	571 (75.2)
2	130 (17.1)
3	43 (5.7)
4	15 (2)
Difficult intubation†	40 (4.5)
Operators	
Nurse anaesthetist	4 (1)
Senior anaesthetist	36 (25.5)
Resident anaesthetist	0
Successful tracheal intubation	
Direct laryngoscopy (multiple attempts)	8 (20)
Gum elastic bougie	28 (70)
Videolaryngoscopy	2
Fastrach™	1
Fibreoptic bronchoscopy	1
Failed intubation (laryngeal mask)‡	5 (0.56)

Primary endpoint

Hypoxaemia (SpO_2 ≤95%) was observed in 172 women (19%; CI, 17–22%) and severe hypoxaemia (SpO_2 ≤90%) in 84 women (9.4% CI, 7.6–11.3%) (Table 5). The minimal SpO_2 observed during airway management was 97% (7) (range 40–100%). Factors associated with maternal hypoxaemia in the multivariate analysis were difficult or failed intubation (adjusted OR=19.1 [8.6–42.7], P<0.0001) and BMI >35 kg m^{-2} (adjusted OR=0.53 [0.28–0.998], P=0.0495).

Secondary endpoint

Factors associated with difficult or failed intubation in the multivariate analysis were Mallampati score >2 (adjusted OR=2.4 [1.2–4.7], P=0.01), limited mouth opening (adjusted OR=3.8 [1.7–8.5], P=0.002), limited mandibular protrusion (adjusted OR=5.7 [1.6–20], P=0.01), and the use of a hypnotic drug other than propofol (adjusted OR=25 [2–391], P=0.02) (Table 6). The analysis using a PS with IPTW showed similar results for the use of hypnotic drug other than propofol (P<0.001).

Discussion

This large multicentre prospective study reports for the first time the incidence of hypoxaemia and its determinants during induction of GA for non-elective Caesarean delivery. Hypoxaemia (SpO_2 ≤95%) was observed in up to 20% of women and was mainly associated with difficult or failed intubation. It is noteworthy that the use of hypnotic drugs other than propofol was an important risk factor for difficult or failed intubation.

We found that the incidence of hypoxaemia (19%) and severe hypoxaemia (9.4%) was much higher than those observed in the general population. Indeed, a recent prospective observational multicentre study reported an incidence of hypoxaemia and severe hypoxaemia of 6.6% and 1.4% at the time of GA induction among adult non-obstetric patients.[12] However, in the context of rapid sequence induction, up to 13% of patients experienced hypoxaemia in the operating room and in a pre-hospital setting.[12,13] Furthermore, physiological changes associated with pregnancy induce a reduced respiratory residual capacity and an increase in overall oxygen consumption exposing the pregnant women to an increased risk of hypoxaemia. Also, the airway management is known to be difficult in this population.[4,14] Therefore, GA for emergent Caesarean section is one of the most stressful anaesthetic situations as it brings an increasing risk of adverse events as compared with neuraxial anaesthesia.[15] These arguments support the relevance of specific guidelines for airway management in the obstetric population.[10]

Preoxygenation

In the present study and as previously reported in non-obstetric setting, failure of preoxygenation (FeO_2 <90%) was

Table 5 Factors associated with hypoxaemia (SpO_2 ≤95%) in univariate and multivariate analysis. Data are presented as mean (SD) or (range); or *n* (%). *SpO_2 (%), value at the end of preoxygenation. †Resident anaesthetist: novice as compared with a trained nurse or a senior anaesthetist. aOR, adjusted odds ratio; CI, confidence interval; CS, Caesarean section; NIV, noninvasive ventilation; SD, standard deviation.

	SpO_2 ≤95%* 172 (19)	SpO_2 >95%* 723 (81)	Univariate *P*	Multivariate aOR (CI), *P*
Age (yr)	31 (18–48)	31 (18–56)	0.44	
BMI (kg m^{-2})	28.2 (4.8)	29.5 (5.5)	0.007	
BMI >35 (kg m^{-2})	13 (8.3)	98 (15.5)	0.02	0.53 (0.28–0.998), *P*=0.0495
ASA physical status >2	12 (7.4)	43 (6.2)	0.59	
Preeclampsia/eclampsia	14 (8.1)	78 (10.8)	0.30	
CS category 1	76 (44.4)	363 (51.9)	0.08	0.75 (0.5–1.1), *P*=0.14
Preoxygenation:				
Tidal volume breathing	126 (75.4)	548 (78.2)	0.65	
Vital capacity breath	39 (23.4)	146 (20.8)		
NIV	2 (1.2)	7 (1)		
FeO_2 <90%	91 (54.8)	387 (58.3)	0.42	
SpO_2 (%)†	100 (1)	100 (1)	0.59	
Hypnotic drug				
Other than propofol	131 (77.1)	523 (72.7)	0.25	
Difficult or failed intubation	35 (20.3)	10 (1.4)	<0.0001	19.1 (8.6–42.7), *P*<0.0001
Resident anaesthetist‡	61 (35.5)	278 (38.5)	0.47	

observed in up to 50% of patients.[12,16] In contrast with those studies, we did not find that failed preoxygenation was a contributing factor of hypoxaemia. This result might be explained by an increased vigilance from caregivers towards hypoxaemia in the context of failed preoxygenation. Indeed, clinicians are increasingly aware that effective preoxygenation is crucial in the pregnant patient as the duration of apnoea without desaturation is very short.[17] We observed that tidal volume breathing and vital capacity breaths were the preferred standardised preoxygenation methods. To date, no validated alternative method has been shown to be effective for the purpose of preoxygenation in this setting. Head up or ramped position increase the duration of apnoea without desaturation in the general population, but not significantly in pregnant women at term.[18] Despite encouraging results in non-obstetrical settings, high-flow humidified nasal preoxygenation appears to be inadequate to achieve appropriate FeO_2 in pregnant women.[19] Noninvasive ventilation has not been evaluated for Caesarean section under GA. Finally, our results suggest that although considering that the urgency of fetal extraction dictates the time available for anaesthetic induction, obtaining a FeO_2 ≥90% must remain a priority objective even if it extends the duration of preoxygenation.[12]

BMI

Obese patients have a decreased functional residual capacity leading to a reduced oxygen supply during periods of apnoea.[20] In this observational study, hypoxaemia occurred less frequently in parturients with high BMI. Because of the observational design, this unexpected result may reflect a better preventive attitude and optimisation of practices in this

Table 6 Factors associated with difficult or failed intubation using univariate and multivariate analysis. Data are presented as mean (standard deviation) or *n* (%). *Resident anaesthetist: novice as compared with a trained nurse or a senior anaesthetist. aOR, adjusted odds ratio; CI, confidence interval; CS, Caesarean section.

	Intubation		Univariate *P*	Multivariate aOR (CI), *P*
	Difficult/failed 45 (5)	Easy 850 (95)		
Age (yr)	31 (6)	31 (6)	0.88	
Mean BMI (kg m^{-2})	28.5 (4.1)	29.2 (5.5)	0.40	
BMI >35 (kg m^{-2})	3 (7,5)	108 (14.4)	0.22	
ASA physical status >2	3 (7.3)	52 (6.4)	0.74	
Pre-eclampsia/eclampsia	4 (8.9)	88 (10.4)	0.99	
CS category 1	20 (44.4)	419 (50.8)	0.41	
Mallampati >2	18 (40)	136 (16.7)	0.0001	2.4 (1.2–4.7), *P*=0.01
Limited thyromental distance	6 (13.3)	43 (5.2)	0.034	1.7 (0.6–4.7), *P*=0.27
Limited mouth opening	11 (24.4)	54 (6.4)	0.0002	3.8 (1.7–8.5), *P*=0.002
Limited mandibular protrusion	4 (9.3)	11 (1.3)	0.005	5.7 (1.6–20), *P*=0.001
Hypnotic drug:				
Other than propofol	41 (100)	613 (72.3)	0.0001	25 (2–391), *P*=0.02
Resident anaesthetist*	24 (53.3)	315 (37.1)	0.03	1.9 (0.97–3.6), *P*=0.06

at-risk sub-population concerning preoxygenation technic (duration, ramped position) or tracheal intubation (experienced operator from the outset).

Difficult and failed intubation

As expected, difficult or failed intubation was also a risk factor of maternal hypoxaemia. The incidences of difficult intubation (4.5%) and failed intubation (0.56%) are similar to those reported in the UK prospective population-based study.[21] In this study, first-line direct laryngoscopy was used. According to the most recent guidelines, it is likely that in the future videolaryngoscopy, instead of direct laryngoscopy, will be the preferred technique in parturients with recognised risk factors for difficult intubation.[9,10]

We found that the use of propofol as compared with other hypnotic drugs, mainly thiopental, was protective for difficult or failed intubation. In our study, propofol was the preferred induction agent for 27% of the procedures. Recent surveys in France and England reported a decrease in thiopental use and an increase in support for the move to propofol.[22,23] Over the past years, there has been a growing debate on the proposal to replace thiopental with propofol for GA induction for Caesarean section.[24,25] A recent meta-analysis indicates that propofol and thiopental are equally suited for Caesarean section regarding maternal systolic blood pressure and awareness and Apgar scores and umbilical blood gas.[26] However, to date, propofol and thiopental have not been compared for airway management in obstetrics.

The quality of tracheal intubation depends on the abolition of upper airway reflexes related to central nervous system depression induced by intravenous hypnotics and by paralysis of the laryngeal muscles induced by neuromuscular blocking agents. With a $\leq$60 s onset time of paralysis, suxamethonium is the recommended neuromuscular blocking agent in this setting.[27] Regarding hypnotics, propofol exhibits a deeper depressant effect on pharyngeal and laryngeal reactivity and a better visualisation of the vocal cords during laryngoscopy as compared with thiopental.[28,29] In addition, further doses of propofol can be given, thus prolonging the opportunity to attempt intubation. Therefore, it is not surprising that propofol may improve airway management as compared with thiopental in the context of obstetric anaesthesia.

Limitations

Completeness of reporting cases was variable according to the maternity unit (79%; range, 60–95%), with some missing data such as Cormack and Lehane classification. Data on history of difficult intubation were not collected. All data were collected from secondary and tertiary maternity services with important proportions of women with comorbidities as compared with primary maternity services. There is a wide variation between units in the proportion of emergency Caesarean section performed under GA (range 3.6–12.3%) partially explained by teaching *vs* non-teaching units, variations in the management of epidural analgesia during labour, the proportion of high-risk pregnancies, or both. We found that propofol protected against the occurrence of difficult or failed intubation. However, it should be noted that this is an exploratory study, not a validation one. Further investigations are required to confirm that this anaesthetic drug contributor is a genuine risk factor.

Conclusions

Hypoxaemia (SpO_2 <95%) occured in 19% of women during the induction of GA for non-elective Caesarean section. Effective preoxygenation is crucial in pregnant patients. We confirm that difficult or failed tracheal intubation is also a significant risk factor for hypoxaemia in this specific population. Further investigations are required to ascertain that propofol protects against difficult or failed tracheal intubation.

Authors' contributions

Collection of data: AG, CB, FJM, HK, MPB
Analysis of data: CB, EV
Interpretation of data: AG, CB, FJM, HK, MPB
Drafting of the manuscript: CB, FJM, HK, MPB
Conception of the study: CB, FJM, HK, MPB
Supervision of the study: CB
All authors approved the final version of the manuscript

Declarations of interest

The authors declare that they have no conflicts of interest.

Funding

Institutional funding.

Acknowledgements

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Handling editor: Takashi Asai